Appendix 3.1
Affordability Issue Analysis Report

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Issue Statement: Current and anticipated future funding levels are inadequate to maintain the existing road system in a stable and environmentally sound condition. Strategic use of the limited funding to reduce the maintenance workload will be essential to halt or reverse the degradation of road and environmental conditions.

1. Findings

- We anticipate that funding for maintenance and improvement of Forest Service roads will not increase substantially over the next three to five years.
- Current funding of routine maintenance is about 70% of what is needed to provide for safety, provide adequate resource protection, and preserve the road facilities (full custodial maintenance). With current funding:
  - Roads are not being maintained to full standard, or even to a full custodial level.
  - Safety is being adequately protected, and prevention of abnormal storm damage has been adequate.
  - Routine maintenance of proper surface drainage is not being fully achieved, resulting in road damage and excess sediment production.
  - A substantial deferred maintenance backlog has accumulated and continues to grow.
- In the near-term, road managers can most readily alter the costs of grading and ditch & culvert cleaning. Other routine maintenance costs are less responsive to management changes. The primary factors that affect these costs and which road managers can change are:
  - Use – restricting wet weather use reduces costs and has fairly low implementation costs.
  - Design – changing a road from the old, confined-drainage design style to the new, unconfined-drainage design style reduces costs, but is costly to implement.
  - Objective Maintenance Level – ML3 roads are wider and maintained to a higher standard than ML2 roads. Conversion of a ML3 road to ML2 reduces costs, but is costly and there are only a limited number of ML3 available for conversion. Converting a ML2 road to ML1 (closing the road year-round) reduces costs, has low to moderate implementation costs, and a large number of roads that could be converted.
  - Mileage – decommissioning a road reduces costs by reducing the total mileage of roads that need to be maintained. There are a large number

of roads that could be decommissioned, but it is very costly to implement.

Table A3.1- 1 displays the range of savings and investment costs associated with several management changes.

Table A3.1- 1 – Investment Costs and Annual Savings for Various Management Changes

Management Change	Costs and Savings per Mile			
	ML2		ML3	
	Savings ($)	Investment ($1000)	Savings ($)	Investment ($1000)
Regulate Wet Weather Use	210 - 250	0.8	260 – 300	1.2
Convert to New Style	80 – 120	11.5	90 – 150	19.2
Close	110 – 410	0 – 4.6		
Decommission	170 – 500	24.0		
Convert ML3 to ML2			70 – 470	2.9 – 20.4

- We estimate that grading and ditch & culvert cleaning costs should not exceed about 75% of the total routine maintenance budget, in order to provide for full custodial level of routine maintenance. At the current funding level 75% would be about $320,000. Table A3.1- 2 displays the degree to which implementing the more feasible of the above-listed management changes could increase the overall affordability of the routine maintenance workload.

Table A3.1- 2 – Costs of Feasible Management Strategies				
	Annual Grading + Ditch & Culvert Cleaning Costs		Capital Investment Needs ($1000)	Miles of Road Closed
Management Scenario	$1000	% of Budget		
Current Situation	446.7	105%	0	0
Restrict Wet Wx Use on All ML2 & ML3 Roads	342.3	80%	372.6	0
Close 50% of ML2 Roads	327.0	77%	1,559.7	555
Restrict Wet Wx Use ML2 & ML3 and Close 15% ML2	318.4	75%	799.8	166

The last scenario appears to provide the most feasible model for reducing grading and ditch & culvert cleaning costs to target levels.

- The most critical portion of the deferred maintenance backlog is replacement of old culverts, because of the substantial sediment impacts and repair costs associated with culvert failure. Current needs exceed $1.6 million, and the majority of remaining culverts will be due for replacement within 10 years.
- Existing management direction under standards and guides for Facilities & Transportation provides adequate direction to manage the affordability of the road system. The results of this analysis support the existing Forest Plan management direction, and identify opportunities and guidance (refer to Guidelines section) to focus and improve its implementation.

2. Guidelines

The following suggestions are intended to assist road managers to effectively implement road-related Forest Plan management direction.

2.1. Need for Forest Plan Amendment – None.

2.2. Identifying Opportunities and Setting Priorities

- When reducing annual maintenance costs is the primary objective, prioritize investment in road management changes according to the investment recapture period. Consider investment recapture period when prioritizing investments in management changes that have other primary objectives.
- Replacement of old culverts with high risk of failure should receive highest priority for deferred maintenance funding.
- For affordability purposes, unneeded roads with a high percentage of their culverts needing replacement should have the highest priority for decommissioning.
- Unneeded roads with the highest maintenance costs should have the next highest priority.

2.3. Watershed and Project Scale Analysis

- Identify and prioritize road-specific opportunities to reduce road maintenance workload.
- Identify where culvert replacement needs are most urgent on unneeded roads.
- Identify opportunities where deferred maintenance work can also accomplish conversion of roads with old style design to new style.
- Identify roads with high recurring maintenance or repair costs, and opportunities to reduce those costs.
- Establish road closure mileage goals commensurate with expected funding levels and in conjunction with the determination of needed vs. unneeded roads. Justify deviation from the forest-wide goal of 15% of 2002 ML2 mileage. If the watershed goal is established below the forest-wide goal, then account for where on the forest the slack should be taken-up.
- Evaluate the effect of proposed road management changes on maintenance workload.

2.4. Construction

- Applicable Forest Plan standards and guides: Facilities & Transportation #11, 12, 14.

- Assure that the long-term maintenance needs of proposed new roads can be supported by expected funding. Usually this will be done by assuring that the new construction will not prevent the achievement of the watershed's goal for reduction of ML2 mileage.

2.5. Reconstruction, and Deferred Maintenance

- Applicable Forest Plan standards and guides: Facilities & Transportation #3.
- When conducting deferred maintenance of the road surface on in-sloped roads, take the opportunity to out-slope the road at the same time.

2.6. Operation and Maintenance

- Applicable Forest Plan standards and guides: Facilities & Transportation # 3, 13, 14.
- Maximize the use of wet weather use restrictions to reduce routine maintenance costs.
- Continue to cooperate with County and private road managers in maintaining the shared road system.

2.7. Closure & Decommissioning

- Applicable Forest Plan standards and guides: Facilities & Transportation #4.
- Use gates or other removable barriers to close unneeded roads that have known culvert plugging risk, so that there is ready access for cleaning and storm patrol. Decommissioning such roads would be acceptable if they meet other affordability prioritization criteria.
- Develop a schedule and funding strategy for closing 15% ML2 roads forest-wide. Adjust the schedule, strategy, and closure percentage goal as needed to reflect changes in funding and refinement of road maintenance cost information. The 15% figure should not be considered a fixed target so much as an interim estimate subject to change as circumstances change. The underlying objective is to bring the workload into line with available funding.
- Take advantage of opportunities to share closure costs by converting roads to trails.

3. Analysis

This discussion focuses primarily on the roads under Forest Service jurisdiction. As discussed below, the development of the affordability issue is strongly linked to a significant change in land use on the National Forest since the late 1980s. These changes have also had some indirect effects on our road management partners, the county road managers and industrial forestland owners. However, the bulk of the problem, as well as the potential solutions, are within Forest Service jurisdiction. Hopefully, our partners may find some of our findings and guidelines useful in improving the affordability of their roads within the Mendocino NF.

3.1. Development of the Road System and the Current Funding Shortfall

From the late 1950's to the mid 1980's, the bulk of the forest road system was developed to support the harvest and management of commercial timberlands. During this period, when timber production was at its peak, timber sale revenues accomplished a large share of the maintenance on Forest Service roads either directly or indirectly. Since the decline of the National Forest timber sale activities in the mid 1980's, the amount of road maintenance accomplished by timber sale revenues has declined substantially. Appropriated funding for road maintenance also declined along with the decline in timber harvest.

However, the road system did not shrink along with timber revenues and appropriated funding. So, the maintenance workload did not decline along with funding levels. As a result, the available funding soon became inadequate to keep Forest Service roads fully maintained to standard. The situation has not been so acute on roads that are cooperatively maintained by industrial forestland managers, as their harvest-related maintenance has not declined so much as has the Forest Service's.

3.2. Maintenance Workload vs. Current and Future Funding

The following discussions will frequently refer to roads by their objective maintenance level, because the maintenance level is directly related to maintenance costs. Maintenance levels are defined in the glossary, but in general, the higher the number the higher the level of maintenance the road requires. The shorthand 'ML1', 'ML2', etc. will be used to refer to the various objective maintenance levels in the text and tables.

3.2.1. Routine Maintenance

The Forest budget for routine maintenance averaged $383,000 per year between 1999 and 2002. There was an increasing trend in funding over the period, with funding in 2002 about 30% higher than in 1999 ($426,100 vs $325,000). This equates to about a 10% average annual increase, but this rate cannot be used with confidence to project future increases. There was no increase between

2001 and 2002, and the national focus on the war on terrorism is likely to affect previous commitments to increase funding for maintenance of National Forest roads. We assume for this analysis that annual funding will not grow significantly above the 2002 funding level for the next thee to five years.

Table A3.1- 3 displays the annual costs of fully maintaining the Mendocino NF road system. The funding needs are over four times the 2002 funding level. Even if the trend of 10% annual budget increase were to continue, it would take more than 15 years to catch up with the cost of fully maintaining the existing road system to established objectives.

Table A3.1- 3 – Annual Costs of Routine Maintenance

Mtc. Level	Miles	Aggregate Maintenance Needs ($)	Average Maintenance Needs ($/mi)
ML1	974	$136,360	$140
ML 2	1119	$629,561	$563
ML 3	338	$781,261	$2,311
ML 4,5	42	$219,931	$5,236
Totals/Averages	2431	$1,767,113	$727

With funding at about 20% to 25% of what is needed, we have not been able to fully maintain the road system to meet established management objectives. In fact, we have not even been able to meet minimal custodial level of maintenance, in which the primary objectives are public safety, resource protection, and prevention of abnormal storm damage[1]. In this sub-custodial mode we have managed under a sort of triage system in which safety is first priority, prevention of abnormal damage second, minimizing erosion is third, and everything else that can wait is deferred. We have been able to maintain adequate safety and to prevent most abnormal storm damage, but sediment impacts are greater than they should be. This is mainly due to insufficient grading to keep up with the traffic wear.

This has led to declining road conditions for road users, substandard resource protection, incomplete condition data, and a substantial backlog of deferred maintenance workload (discussed in more detail below). Most alarming of these is the deferred maintenance backlog, some of which could result in substantial resource and road damage costs if not corrected.

Although the counties manage only about 240 miles of roads (less than 10%) within the Forest boundary, those roads are a key component of the transportation system on the Forest. They comprise a substantial portion of the

[1] An example of abnormal damage would be to have extensive stream crossing failures during moderate storm events due to inadequate culvert cleaning. Such failures would be due more to inadequate maintenance than to the severity of the storm event.

identified key routes, and they provide virtually all of the entry portals to lands within the Forest boundary.

The Counties receive part of their funding for road maintenance based on the amount of licensed vehicles that are in their County. Another portion of their funding comes from a percentage of the gasoline tax from the State. A third source of funding is from the Forest Service under the Secure Rural Schools and Community Self-Determination Act of 2000.

The counties have experienced some decline in their road maintenance budgets also. The reduced level of timber harvest on National Forest lands reduced the amount of money returned to the counties by the federal government in lieu of taxes. Fortunately for the counties, this reduction has been tempered by the recent passage of the Secure Rural Schools and Community Self-Determination Act of 2000. Although the Act does not restore funding to its peak levels, it does provide more funding than the old formula, and is more stable.

3.3.2. Deferred Maintenance

Table 3.1- 4 displays deferred maintenance needs for Forest Service roads. The information comes from the INFRA database, and probably underestimates the actual amount of work because of incomplete inventory data. Nevertheless, it provides a good sense of the magnitude of the backlog situation.

Table 3.1- 4 – Deferred Maintenance Backlog[2]

Category	Amount	% of Deferred Mtc
Culvert	$2,756,714	38%
Drainage	$1,004,817	14%
Signs/Traffic Ctl	$113,845	2%
Structures	$11,100	0%
Surface / Roadway	$3,183,275	44%
Vegetation	$132,358	2%
Total	**$7,202,109**	

In recent years, between $300,000 and $500,000 has been available for deferred maintenance work. Additional minor amounts of work have been accomplished with timber sale revenues, and the few miles of road decommissioning has permanently eliminated some backlog. If this rate of funding continues, it would take over 18 years to eliminate the backlog, even if no additional backlog accrues in the mean time. However, at current funding levels for routine maintenance, additional backlog will accrue.

[2] From INFRA database (II_ROAD_WORK_ITEMS_V table), data extracted September 2002. Condition data mostly complete for ML3+ roads, incomplete for ML1 & ML2 roads.

Unfortunately, with inadequate condition surveys, we do not have information in enough detail to determine the average rate of backlog accrual. However, one indicator we do have is the culvert replacement problem. INFRA data indicates an average replacement cost of about $10,000 per culvert for documented replacement needs. GIS analysis indicates that the average number of stream crossings per mile of road is 2.5, which equates to an average cost per mile for culvert replacement of $25,000. Based upon an average 30-year replacement cycle, this equates to about $833 per mile per year (or $1.24 million for all ML2, 3 and 4 roads) to provide for timely culvert replacement. This amount is definitely not provided for by current funding, and so accrues to the deferred maintenance workload. Suffice it to say that the situation demands a strategy to attack both the existing backlog and the rate of accrual.

3.3. Coping with the Funding Shortfall

3.3.1. Routine Maintenance

Under full custodial maintenance, priority maintenance activities address immediate needs such as correcting safety problems, preventing culvert failure, and maintaining proper surface drainage. Work items that can be postponed, such as brush clearing, scheduled culvert and sign replacement, grading for user comfort, and condition inventories are deferred until they are more urgently needed.

Custodial maintenance of ML2 and ML3 roads includes blading and shaping of the road surface (without watering), cleaning culverts, and condition surveys sufficient to identify high priority work. The average annual custodial maintenance expenditures for ML3 roads average about $640 per mile annually. The average custodial cost for ML2 roads is about $540 per mile actually maintained. Grading should occur on a one to three year cycle to maintain proper drainage and minimize erosion, depending on the design and use of the road.

As noted above, we have resorted to a triage-custodial level of routine maintenance. Only about 300 of the 1109 miles of ML2 is graded each year. This equates to an average rotation of about 4 years between grading, or an annual average expenditure of about $120 per mile. Highly impacted ML2 roads are maintained each year, while roads with lesser impacts go longer between maintenance. This grading cycle is not frequent enough to maintain proper surface drainage on many roads, so they produce more sediment than is acceptable.

The average cost for ML1 roads is about $65 per mile for condition surveys, plus any additional costs for spot-correction of drainage or culvert problems that are detected by condition surveys. Only about 10% of ML1 roads are formally surveyed each year; roads with a history of drainage problems are given priority for more frequent survey.

Under custodial maintenance, non-critical maintenance items are performed less frequently, or deferred until they do become critical. Brush removal is not done on a regular basis because of the costs, surface replacement on rocked roads which runs around $150,000 per mile is not done, and the replacement of worn out culverts is falling behind except for ones that can be done easily (stream crossings with small fills).

A management practice that has helped reduce maintenance costs is the implementation of closures during the wet season. This has been used primarily on the Covelo Ranger District, and has helped prevent rutting on the roads, which is more severe when the roads are wet. The amount of grading work needed to maintain proper drainage is much greater on rutted roads. We have found that on the average the production rate for grading on a seasonally closed road is about 50% greater than for roads that are open to traffic in the winter.

So far, custodial maintenance has kept roads to a point that they are safe for the forest visitor, and it has limited resource and road damage. However, the backlog of deferred maintenance on these roads has continued to grow.

A big help with the road maintenance workload is through a Maintenance Agreement with two large industrial forestland owners. Crane Mills owns a large portion of land in the north end of the Forest, and Pioneer Industries owns another large tract of land in the center of the Forest. These land owners share in the maintenance of many miles of road that provide access both to their lands and to National Forest lands. Without this cooperation, the unmet annual and deferred maintenance work would be even higher.

Pioneer has recently harvested a large portion of their merchantable timber, and is seeking to divest itself of its land holdings within the Mendocino NF. Regardless of future ownership, we anticipate that near-term harvest levels and associated road maintenance activities will be substantially lower than in the past. Fortunately, the road manager at Pioneer (and its predecessor, Louisiana Pacific Corp.) modified many of their roads, and cooperated with Glenn County and Mendocino NF to modify cooperatively maintained roads to be less expensive to maintain. This will significantly mitigate the anticipated lower level of maintenance expenditures.

3.3.2. Deferred Maintenance

Available funding for deferred maintenance projects has been prioritized based on the following criteria. Projects that meet more criteria receive higher priority for funding:

- Located in a Key Watershed.
- Reduces risk of stream crossing failure.
- Reduces significant chronic sediment production.
- Reduces routine maintenance costs.
- Has one or more partners to share the cost.

When funding is available, we are out-sloping ML2 roads and using rolling dips, this has reduced the maintenance costs on these roads. We have received special funding to do this on one ML3 road to reduce the maintenance cost also.

Additional deferred maintenance has been accomplished with timber sale revenues. Between 1995 and 2001 about 160 miles of deferred maintenance has been accomplished, including about 33 miles of outsloping.

Road decommissioning has been utilized as a means of permanently eliminating the deferred maintenance workload associated with the decommissioned road. INFRA records show about 30 miles of classified roads have been decommissioned since 1995. Similar mileages of unclassified roads were decommissioned during the same period. Fiscal year 2003 funding for decommissioning is $36,200 for five miles of road ($7240/mile). This is a higher rate per mile than past funding rates, but is still only about 30% of the estimated average cost of decommissioning ML2 roads. As a result, decommissioning must focus on roads with below average number and size of stream crossings, which are less expensive to do. Selection of such roads reduces surface maintenance workload, but probably does not make significant inroads on culvert-related deferred maintenance, which is probably the most critical deferred maintenance category.

Another program that can help with deferred maintenance is Title II of the Secure Rural Schools and Community Self-Determination Act. Title II projects must be recommended by county Resource Advisory Committees. At lease 50 percent of all project funds used for Title II projects must be dedicated to either 1) road maintenance, decommissioning, or obliteration; or 2) restoration of streams and watersheds. These projects can be implemented on either County or Forest Service roads.

For example, projects currently planned for the Title II funds for road maintenance include the additional grading on M8 and Lake County Road 301, and road decommissioning of an unclassified road.

Cooperative maintenance (both routine and deferred) performed by Crane Mills and Pioneer Resources has kept the deferred maintenance backlog on cooperatively maintained roads much smaller than for the average forest road.

3.4. Opportunities to Increase Affordability

The previous discussions have painted a fairly gloomy picture. However, it is not our intent to wring our hands and bemoan the situation. Rather, we propose that the need for decisive action is clear, and that we have enough information to proceed. This section suggests some opportunities to improve the situation.

Up to this point, our discussions have centered on average costs. In reality, there are no roads with ‘average’ costs. Each road has a unique combination of design, operation, environmental, and use characteristics that affect its maintenance costs. Fortunately management can alter some of these characteristics in order to reduce maintenance costs. The following discussions

will outline the maintenance workload effects of various road characteristics, and what management can do about them.

The discussion centers on the differences in costs of grading and of cleaning ditches and culverts as affected by design, operation, and use characteristics. These are the maintenance costs and road characteristics that road managers can most readily alter.

A brief explanation of the terms we use to describe these characteristics is in order before proceeding.

- Design Style – Two styles are discussed, referred to as 'old' and 'new'. Old style roads are predominantly of a confined drainage design, characterized by an in-sloped running surface, inboard ditches with ditch relief culverts, and outboard berms. New style roads are predominantly of an unconfined drainage design, characterized by an outsloped running surface, rolling dips for cross drainage, and with minimal inboard ditches and outboard berms.
- Wet Weather Use – Two regimes are discussed: unrestricted and restricted. The unrestricted use regime allows use during the wet season, and results in more severe rutting. This, in turn, increases the cost of grading.
- Objective Maintenance Level – The discussion focuses on ML2 and ML3 roads, as their maintenance workload comprises most of workload, and consequently offer the greatest opportunities for reductions. ML3 roads are wider and maintained to a higher standard than ML2 roads.

A note about the basis for our cost analysis: Under the custodial maintenance regime, condition surveys have been focused primarily on identifying and prioritizing the annual maintenance work. So, inventory and record keeping have not been extensive or detailed enough to produce detailed facts and figures upon which to base our analysis. For this reason we relied upon the experience of the District Engineers to inform our estimates. This is the best information we have to go on for now.

3.4.1. Routine Maintenance

Design style affects the costs of both grading and ditch and culvert cleaning. Old style roads take about 20% longer per mile to grade than new style roads, due primarily to the extra work of cleaning the ditch. Old style roads take about 2/3 longer to clean than new style roads because of the higher number of ditch relief culverts (Smith, pers. com.).

Wet weather use affects the cost of grading. Roads that are rutted by wet weather use take about 50% longer to grade per mile than unrutted roads (Smith, pers. com.). Rutted roads must also be graded more frequently to maintain proper drainage. Some roads are naturally protected from wet weather use, such as those above the permanent winter snow line (~5000 feet elevation), or those that are otherwise inaccessible in winter. However, such protection can be

easily lost if the snow is plowed from the roads[3]. We estimate that about 70% of the road system is naturally protected from wet weather use.

Several factors contribute to the higher cost of maintaining ML3 roads as compared to ML2 roads. ML3 are 2/3 wider(25 ft. vs. 15 ft.), which increases the cost of grading. They are used more heavily and have a higher standard of maintenance, so they require more frequent grading.

Tables A3.1- 5, 6 and 7 display the cost effects of these road characteristics.

Table A3.1- 5 – Grading Cost Differences

Style	Style Multiplier[4]	Wet Weather Use	Wet Weather Use Multiplier[5]	Costs[6] ($/mi)	
				ML 2	ML 3
Average	-	**Average**	-	250	350
Old	1.09	**Unrestricted**	1.2	327	458
		Restricted	0.8	218	305
New	0.91	**Unrestricted**	1.2	273	382
		Restricted	0.8	182	255

Table A3.1- 6 – Ditch and Culvert Cleaning Cost Differences

Style	Multiplier	Cost ($/mi)
Average	-	150
Old	1.15	173
New	0.69	104

[3] Careless plowing can cause direct damage to the road surface by equipment or improper melt-water relief. It also usually results in rutting unless extraordinary measures are taken to restrict traffic until the road dries out. The net effect of plowing snow is usually that limited operation and maintenance funds are expended (on plowing), which adds to the under-funded grading workload.

[4] Multiply times the average cost to determine the effect of design style on actual costs.

[5] Multiply times the average cost to determine the effect of wet weather use on actual costs.

[6] These are dry-blading costs. Use of water trucks would increase costs by 80% to 100%.

Table A3.1- 7 – Combined Annualized Cost Differences (for Grading and Culvert / Ditch Cleaning)							
			Grading Costs				
Mtc Level	Style	Wet Weather Use	Cost per Grading ($/mi)	How Often[7]	Avg Annual Cost	Culvert & Ditch Cleaning	Combined Costs
ML2	Old	Unrestricted	327	1	327	173	500
		Restricted	218	3	73		246
	New	Unrestricted	273	1	273	104	377
		Restricted	182	3	61		165
ML3	Old	Unrestricted	458	1	458	173	631
		Restricted	305	2	153		326
	New	Unrestricted	382	1	382	104	486
		Restricted	255	2	128		232

Table 3.1- 7 shows the substantial differences that the various road characteristics have on maintenance costs. The next question that arises is the cost of changing road characteristics in order to achieve reduced annual maintenance costs. To get at the answer, we determined what management actions would be needed to change each characteristic, and then estimated the typical capital investment cost to implement the change.

Restrict Wet Weather Use : To change from an unrestricted use regime to restricted, a gate must be installed to block traffic during the wet season. So the cost per mile was estimated as the average cost of installing a gate, divided by the average length of road that is closed by a gate. The assumptions for ML2 and ML3 roads are detailed below. Note that these assumptions actually overestimate the cost per mile for ML3 roads, because they only consider the average number of miles of the ML3 road that are closed. In real life, closing any ML3 road will also effectively close a number of ML2 roads that are tributary to the ML3. However, this is so variable forest-wide that it is more fruitful to assess this at the watershed or project scale, using site-specific numbers.

- ML2 Use Restriction Cost – Average cost to install a gate is estimated to be about $1,500. The average length of ML2 road (from INFRA) is 1.84 miles. Average cost per mile = $815.
- ML3 Use Restriction Cost – Average cost to install a gate is estimated to be about $6,000. The average length of ML3 road was estimated to be about 5 miles, based on an ocular estimate of the average actual mileage

[7] Yearly interval between grading.

from which a gate would restrict traffic. We considered only the length of the road from the gate to where traffic is naturally restricted by the permanent winter snow line. Average cost per mile = $1,200.

Convert to New Design Style: To change the design style from old to new, the road template must be reshaped to remove outboard berms and inboard ditches, create an out-sloped running surface, and construct drainage dips to ensure proper cross drainage. Most of our experience with this type of conversion is with ML2 roads, which cost on average $11,500 per mile (Smith, Stevens, pers. com.). The cost to convert ML3 roads was assumed to be higher, proportional to its greater width: $11,500 x 25 / 15 = $19,166 (rounded to $19, 200 in the tables).

Convert ML3 to ML2: There may be some opportunities to convert ML3 roads to ML2, if changed access needs no longer require a high standard road. This would involve narrowing the running surface by pulling material from the outboard edge of the road and placing in on the narrowed running surface. We estimated that the cost of this work was similar enough to changing the design style that it could be considered to be the same. We also assumed that the resulting road template would be constructed to the new style, as the cost would be the same to construct to the old style, but would accrue only about half the annual maintenance savings.

Year-Round Closure: Implementing year-round closure on a road eliminates grading costs and reduces the cost of cleaning ditches and culverts by about 50%. Old style roads need to be storm-proofed before closure, to ensure that the decreased maintenance of ditches and culverts does not result in storm damage. This involves pulling berms and constructing dips or waterbars to ensure cross drainage and prevent stream diversion. The cost of this was estimated to be about 1/3 of the cost of converting from old style to new ($11,500 / 3 = $3,833). The cost of implementing year-round closure on new style roads is the same as implementing seasonal restrictions, as it only requires blocking traffic with a gate.

Decommission: We have only one decommission project upon which to base our average decommissioning costs. This was the Stick Lake Road closure on the Covelo Ranger District. This was a ML3 road at mid-slope, with typical stream crossing fill dimensions (the major factor affecting cost). This was a minimal decommissioning, involving the removal of stream crossings, stabilizing of excavated fill material, and outsloping of the road surface. Most of our other decommissioning projects have been constrained by funding to the ‘easy-to-do’ category of roads – those with either no stream crossings, or only a few small ones – so they do not reflect the capital costs for decommissioning typical roads.

The cost to decommission the Stick Lake Road was about $40,000 per mile. We estimated the cost of a ML2 road to be less in proportion to it’s narrower profile: $40,000 x 15 / 25 = $24,000.

We calculated the annual savings associated with each of the above management changes by subtracting the annual maintenance cost after the

management change from the annual cost before the change. For example the savings from restricting wet weather use on an old style ML2 road that is currently unrestricted would be $500 - $246 = $254.

We also calculated the approximate number of years to recapture the capital investment by dividing the capital investment cost by the annual savings. Using the same example as before, this would be $815 / $254 per year = 3.2 years. The results of our calculations are displayed in Tables A3.1 – 8 & 9.

It is important to remember that the current costs and potential savings shown in these tables are based upon idealized maintenance cycles. Under current funding levels, the costs are not being fully funded, so maintenance cycles have had to be extended. For this reason, initial savings resulting from management changes will not show up as surplus cash. Rather, savings will produce an improved match between funding levels and maintenance needs.

In theory, a road manager with limited funding would make management changes based upon the recapture period, assuming the goal was simply to reduce annual maintenance costs. Changes with the shortest recapture period would be highest priority, as this would free-up funding for additional capital investment sooner. However, road managers must also consider other factors, especially access needs. For example, closure is probably not a viable option for a new style, unrestricted ML2 road that provides access to a campground or popular trailhead, even though that option has the shortest recapture period. However, restricting wet weather use may have acceptable impacts on access, and still has a short recapture period.

If the primary objective is to reduce annual maintenance costs, investment in management changes with recapture periods of over 20 years are probably not justified. This would appear to exclude most management changes other than seasonal use restrictions or year-round closures. However, the more costly management changes can sometimes be achieved with little or no additional expense when other objectives are being pursued.

For example, if an old style road is due for deferred maintenance of its running surface, this can be done in such a way as to convert it from old style to new style at about the same cost. Another example would be when the primary objective is to protect a sensitive resource, such as fish habitat. In such a case, the investment recapture period is not as important a consideration in justifying the investment as is the value of the fish habitat protection. Nevertheless, the savings in annual maintenance costs would be reaped as an added benefit.

Table A3.1- 8 - Costs & Savings Associated with Potential Management Changes on ML2 Roads
(All rates are on a per-mile basis)

Current Management			Costs & Savings per Management Change														
			Restrict Use			Convert to New Style			Convert to New Style & Restrict			Close			Decommission		
Style	Wet Weather Use	Cost[8]	Cap Inv[9]	Savings[10]	Re-Cap[11]	Cap Inv	Savings	Re-Cap	Cap Inv	Savings	Re-Cap	Cap Inv	Savings	Re-Cap	Cap Inv	Savings[12]	Re-Cap[13]
Old	Unrestricted	500	0.8	254	3.2	11.5	123	93.5	12.3	335	36.7	4.6	414	11.2	24.0	500	48.0
	Restricted	246							11.5	81	142.0	3.8	159	24.1	24.0	246	97.7
New	Unrestricted	377	0.8	212	3.8							0.8	325	2.5	24.0	377	63.7
	Restricted	165										0	113	0	24.0	165	145.7

[8] Annual cost ($ per mile) to maintain surface drainage (grading), and keep ditches and culverts clean (other maintenance costs are not significantly affected by the listed management changes.
[9] Capital investment (thousands of $ per mile) needed to implement the management change.
[10] Annual savings in maintenance costs ($ per mile).
[11] Number of years to recapture the capital investment (= capital investment / annual savings)
[12] This represents only the savings in the cost of maintaining surface drainage, and keeping ditches and culverts clean. Significant additional savings would accrue from not having to perform periodic maintenance such as replacing culverts again at the end of the 30-year average lifespan.
[13] The actual capital-recapture period would likely be shorter than 30 yrs – see previous footnote.

Table A3.1- 9 - Costs & Savings Associated with Potential Management Changes on ML3 Roads
(All rates are on a per-mile basis)

Current Management			Costs & Savings per Management Change											
			Restrict Use			Convert to New Style			Convert to New Style & Restrict			Convert to ML2 New Style & Restrict		
Style	Wet Weather Use	Cost	Cap Inv	Savings	Re-Cap	Cap Inv	Savings	Re-Cap	Cap Inv	Savings	Re-Cap	Cap Inv	Savings	Re-Cap
Old	Unrestricted	631	1.2	306	3.9	19.2	145	132.4	20.4	400	51.1	20.4	466	43.7
	Restricted	326							19.2	94	204.3	19.2	161	119.4
New	Unrestricted	486	1.2	255	4.7							4.1	320	12.7
	Restricted	232										2.9	68	43.0

The information in the tables above is based on costs and savings per mile. It is useful for comparing various management options, but not very useful for assessing the relative magnitude of potential savings or the investment needed to achieve the savings. To develop that information, we developed several benchmark scenarios to quantify the magnitude of potential savings and investment costs that would occur under various management strategies.

We analysed several scenarios that drew from all of the management changes displayed in Tables A3.1- 8 & 9, but only three will be discussed here. This is because scenarios that relied on conversion of design style or decommissioning had aggregate investment costs that were clearly unrealistic under anticipated funding levels. This left us with three scenarios that relied on closure, wet weather use restrictions and a combination thereof.

We first estimated the approximate mileage of each category of road under current management and under the different management change scenarios. We then multiplied the cost-per-mile rates for each category (from Tables A3.1- 8 & 9) to the number of miles in that category for each management scenario to derive approximate aggregate costs.

To estimate the mileage currently in each category, we used our estimates of the proportion of the road system in each design style and each wet weather use regime. Recall that we estimate that about 67% of current the ML2 and 3 roads are of the old style design, and 33% are of the new style. Also, about 30% are subject to wet weather use, and 70% have either naturally or administratively restricted wet weather use. To calculate the number of miles in each ML/design style/use category, we used the following formula[14]:

Category miles = ML miles x Design Style % x Use Regime %

For example, to calculate the number of miles of ML2, old style, with unrestricted use:

ML2/Old/Unrestricted miles = 1109 miles x 67% x 30% = 223 miles[15]

This established the estimated current mileage distribution among the categories. We then calculated the effect that each scenario would have on mileage distribution among the categories. Each of the three management change scenarios had a distinct effect on the number of miles in each category:

- Restricting Wet Weather Use on All Roads - changed all roads to the restricted use, but did not affect maintenance level or design style. For example, all ML2/ old-style/unrestricted roads become ML2/old-style/restricted.
- Closing 50% of All ML2 Roads – closed 50% of the miles in each of the four categories of ML2 roads and changed their maintenance level to ML1, but had no effect on ML3 roads.

[14] We assumed even distribution of the design and use characteristics across the system. Neither our GIS nor INFRA tracks these characteristics, so there is no basis for using other than an even distribution.

[15] This a best estimate, and should not be considered a precise figure.

- Restricting Wet Weather Use on All Roads & Closing 15% of ML2 Roads – changed all roads to the restricted use, and changed 15% of ML2 roads to ML1.

The last step was to multiply the mileages by the cost factors from Tables A3.1- 8 & 9 to get the aggregate costs.

Keep in mind that the costs being analysed are only for grading and ditch/culvert cleaning on current ML2 and 3 roads, the costs that are most responsive to management changes. These are only a part of the cost of the custodial level of routine maintenance of the road system. ML1, 4, and 5 roads also need work, and ML2 and 3 roads need work in addition to grading and ditch/culvert cleaning.

Under the current 'triage' custodial management, about 85% to 90% of the annual routine maintenance fund goes to grading and ditch/culvert cleaning on ML2 and 3 roads. We estimate that under full custodial management, this should not be more than 75% to 80% of the routine maintenance budget, in order to provide more equitable funding of the other maintenance work. We therefore propose to use 75% of the 2002 routine maintenance budget as a measure for comparing the effectiveness of the various scenarios in moving from the current 'triage' situation to at least the full custodial level of maintenance (75% of $426,100 = $319,600).

Table A3.1- 10 - Effects of Management Change Scenarios On Certain Custodial Maintenance Costs
(Includes only grading & ditch/culvert cleaning costs of current ML2 an ML3 roads)

Mtc. Level	Design Style	Wet Weather Use	Current			Restrict Wet Wx Use on All Roads			Close 50% of ML2 Roads			Restrict Use on All Roads & Close 15% of ML 2		
			Miles	Mtc Needs (1,000 $)	Cap Inv (1,000 $)	Miles	Mtc Needs (1,000 $)	Cap Inv (1,000 $)	Miles	Mtc Needs (1,000 $)	Cap Inv (1,000 $)	Miles	Mtc Needs (1,000 $)	Cap Inv (1,000 $)
ML1[16]			0	0	0	0	0	0	555	41.7	0	166	12.5	0
ML2	**Old**	**Unrestricted**	223	111.5	0	0	0	181.6	112	55.7	518.1	0	0	181.7
		Restricted	520	127.8	0	743	182.5	0	260	63.9	996.9	632	155.2	427.2
	New	**Unrestricted**	110	41.4	0	0	0	89.5	55	20.7	44.7	0	0	89.5
		Restricted	226	42.2	0	366	60.3	0	128	21.1	0	311	51.2	0
ML1 & ML2 Sub-Totals			**1109**	**322.8**	**0**	**1109**	**242.8**	**271.2**	**1109**	**203.1**	**1,559.7**	**1109**	**218.9**	**698.4**
ML3	**Old**	**Unrestricted**	57	35.7	0	0	0	67.9	57	35.7	0	0	0	67.9
		Restricted	170	55.3	0	226	73.7	0	170	55.3	0	226	73.7	0
	New	**Unrestricted**	28	13.6	0	0	0	33.5	28	13.6	0	0	0	33.5
		Restricted	84	19.4	0	112	25.8	0	84	19.4	0	112	25.8	0
ML3 Sub-Totals			**338**	**123.9**	**0**	**338**	**99.5**	**101.4**	**338**	**123.9**	**0**	**338**	**99.5**	**101.4**
Totals			**1447**	**446.7**	**0**	**1447**	**342.3**	**372.6**	**1447**	**327.0**	**1,559.7**	**1447**	**318.4**	**799.8**

[16] Includes only those ML1 roads created by closure of ML2 roads under these scenarios.

Under the “Current” scenario, we see that the funding needed to accomplish the full custodial level of grading and ditch/culvert cleaning on ML2 and ML3 roads is about $447,000. This exceeds the proposed level of $319,600 by about 40%, and total fiscal year 2002 funding by 5%. Put another way, current funding for routine maintenance is about 70% of what is needed to provide full custodial maintenance.

Under the “Restrict Use” scenario, the funding needed still exceeds the proposed level by about 7%, but at least it is less than total current funding. Investment costs are the lowest of the three change scenarios, and are probably overestimated (recall that seasonal closure of some ML3 roads will eliminate the need to construct gates on some ML 2 roads). Also, in reality not all roads could be put on wet weather restrictions, as they access communities that require year-round access. Thus the amount of reduction in annual costs that could actually be achieved would not be as much as indicated.

Under the “Close 50% ML2” scenario, the annual funding needed exceeds the proposed level by only about 2%. Investment costs are the highest of the three change scenarios, and nearly double the amount of the next highest scenario. Although not pertinent to the affordability issue, the degree of reduction in open road mileage would have a substantially larger impact on road-dependent recreation access than would the other two change scenarios.

Under the “Restrict Use & Close 15% ML2” scenario, the funding needed is just under the proposed level. Investment costs are the median of the three change scenarios, just over double the lowest cost scenario and about half the highest cost scenario. As for the “Restrict Use” scenario, the portion of the investment costs associated with wet weather restrictions are probably overestimated.

We drew several conclusions from these results:

- Wet weather use restrictions are an essential tool for increasing affordability of the annual maintenance workload.
- Wet weather use restrictions alone cannot get us to the full custodial level of routine maintenance of the current road system with anticipated funding levels. Year-round closure of about 15% of ML2 roads will probably also be needed, depending on actual funding levels, and decisions regarding the balance between the funding of deferred maintenance and routine maintenance.
- Maximizing implementation of wet weather use restrictions reduces the amount of investment costs and the miles of year-round closures needed to improve affordability.

3.4.2. Deferred Maintenance

About $1.6 million of the culvert deferred maintenance backlog is for culverts needing replacement. As noted before, this is the portion of the backlog that concerns us the most. While other backlog items have chronic impacts, culvert

failure can result in major repair costs and sediment impacts. For this reason, reduction of the culvert replacement backlog should receive highest priority when allocating deferred maintenance funding.

There are opportunities to reduce routine maintenance and recurring replacement needs by removing old culverts rather than replacing them. Where unneeded roads have substantial culvert replacement needs, decommissioning could be done at a similar cost. Another opportunity would be to replace old culverts on intermittent streams with hardened low-water crossings where appropriate[17]. Such projects would be good candidates for funding from multiple budget line items.

3.4.3. New Construction

Any new construction will obviously add to the existing, under-funded maintenance workload. Therefore, proposals for new road construction should be evaluated for the balance between the economic benefits and the construction and maintenance costs over the life of the road. All new road construction should be in the new design style, so as to minimize routine maintenance workload added to the system.

3.4.4. Other Opportunities

Converting unneeded roads to off-highway vehicle (OHV) trails shifts the maintenance burden from the road maintenance program to the OHV program. Either or both programs could fund the conversion costs. However, new OHV funding is somewhat scarce lately, so opportunities are limited for the time being.

Converting to foot and horseback trails is possible also, but the conversion costs are essentially the same as for decommissioning, and the historic funding levels for foot and horse trails are not sufficient to bear much of the cost.

There may be opportunities for communities within the Forest to form special road maintenance districts for the purpose of improving maintenance of roads that are important to them. Such districts would have the power to levy fees on the membership to pay for maintenance work.

3.4.5. Prioritization by 5th Field Watershed or Key Route

We did not prioritize either watersheds or key routes for implementation of cost-saving management changes. This is because a dollar saved anywhere on the road system benefits the entire system by making more money available for the remaining workload. Also, it is more important to prioritize cost saving actions according to their economic efficiency.

[17] We do not have extensive experience with this practice on FS roads on this Forest, but Louisiana Pacific and Pioneer Resources road managers (principally Richard Dragseth) have done some. Before pursuing this strategy, FS personnel should consult with Mr. Dragseth or his successor regarding the pros and cons.

There are watersheds and key routes that have greater than average opportunities for cost savings. However, it is more productive to let prioritization be driven by economic efficiency criteria and by opportunities to simultaneously address priorities related to other issues. Such information is most appropriately developed at the watershed and project scale.

3.4.6. LRMP Adequacy

Management direction related to affordability is in Standards and Guides for Facilities and Transportation (#3, 4, 11 – 14). The appropriateness of that management direction for guiding road management activities is affirmed by the results of this analysis. The analysis also provides some insights regarding the most effective practices and strategies for implementing LRMP direction. Watershed and project scale roads analysis will be needed to identify and prioritize specific opportunities for improving affordability.

4. The 71 Questions from the RAP Book

This issue is relevant at both the forest scale and watershed/project scale. Of the 71 questions from the RAP book, EC1 is the principle question addressed under this issue (What are the monetary costs associated with the current road system? How do these costs compare to the budgets for management and maintenance of the road system?) The other two questions relating to economic issues deal more with the economic benefits of road access than with the affordability of maintaining that access. For that reason, we addressed those questions under the access issue.

Information Sources

GIS Information Sources

Roads – Cartographic Feature Files, with feature realignments based upon Digital Ortho Quads.

Streams – Cartographic Feature Files, augmented to show predicted occurrence of intermittent streams from contour crenulations; 1:24,000.

Database Sources

Roads - INFRA database. Includes all roads under FS or County jurisdiction, current as of August 2002. Contains no data for privately owned roads.

Persons Cited as Personal Communication

Name	Discipline	Agency
Smith, Bruce	Engineer	Forest Service

Glossary

Annual Maintenance - Work performed to maintain serviceability, or to repair failures during the year in which they occur. Includes preventive and/or cyclic maintenance preformed in the year in which it is scheduled to occur. Unscheduled or catastrophic failures of components or assets may need to be repaired as a part of annual maintenance.

Glossary

Classified Roads – Roads wholly or partially within or adjacent to National Forest System lands that are determined to be needed for long-term motor vehicle access, including State roads, county roads, privately owned roads, National Forest System roads, and other roads authorized by the Forest Service (36 CFR 212.1).

Custodial Maintenance – Sub-standard maintenance level in which priority maintenance activities address immediate needs such as correcting safety problems, preventing culvert failure, and maintaining proper surface drainage. Work items that can be postponed, such as brush clearing, scheduled culvert and sign replacement, grading for user comfort, and condition inventories are deferred until they are more urgently needed.

Deferred Maintenance: Maintenance that was not preformed when it was scheduled and which, therefore, was put off or delayed for a future period.

Design Style - Two styles are discussed, referred to as 'old' and 'new'. ***Old style*** roads are predominantly of a confined drainage design, characterized by an in-sloped running surface, inboard ditches with ditch relief culverts, and outboard berms. ***New style*** roads are predominantly of an unconfined drainage design, characterized by an outsloped running surface, rolling dips for cross drainage, and with minimal inboard ditches and outboard berms.

Key Watershed – A 5th field watershed designated under the Northwest Forest Plan for special management to contribute to anadromous salmonid conservation. Key Watersheds have highest priority for watershed restoration.

Maintenance Level 1 - These roads are closed. Some intermittent use may be authorized. When closed, they must be physically closed with barricades, berms, gates, or other closure devices. Closures must exceed one year. When open, it may be maintained at any other level. When closed to vehicular traffic, they may be suitable and used for non-motorized uses, with custodial maintenance. Surface maintenance is only performed for purposes of drainage control and minimizing erosion.

Maintenance Level 2 - Roads open for use by high-clearance vehicles. Passenger car traffic is discouraged and the surface is not maintained for this use. Traffic is minor administrative, permitted or dispersed recreation. Non-traffic-generated maintenance is minimal. Surface maintenance is only performed for purposes of drainage control.

Maintenance Level 3 - Roads open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are

not considered priorities. Typically low-speed, single-lane with turnouts and native or aggregate surfacing. The road surface is maintained to provide the passage of low-clearance vehicles (i.e., passenger cars).

Maintenance Level 4 - Roads that provide a moderate degree of user comfort and convenience at moderate speeds. Most are double-lane and aggregate surface. Some may be single-lane. Some may be dust abated. The road surface is maintained to provide the passage of low-clearance vehicles (i.e., passenger cars).

Maintenance Level 5 - Roads that provide a high degree of user comfort and convenience. Normally double-lane, paved facilities, or aggregate surface with dust abatement. This is the highest standard of maintenance. The road surface is maintained to provide the passage of low-clearance vehicles (i.e., passenger cars).

Road Decommissioning – Closure and reshaping of the road template that results in the stabilization and restoration of unneeded roads to a more natural state (36 CFR 212.1, FSM 7703).

Road Maintenance – The ongoing upkeep of a road necessary to retain or restore the road to the approved road management objective (FSM 7712.3).

Road Reconstruction – Activity that results in improvement or realignment of an existing classified road as defined below: a) ***Road Improvement*** – Activity that results in an increase of an existing road's traffic service level, expansion of its capacity, or a change in its original design function; b) ***Road Realignment*** – Activity that results in a new location of an existing road or portions of and existing road and treatment of the old roadway (36 CFR 212.1).

Unclassified Roads – Roads on National Forest System lands that are not managed as part of the forest transportation system, such as uplanned roads, abandoned travelways, and off-road vehicle tracks that have not been designated and managed as a trail; and those roads that were once under permit or other authorization and were not decommissioned upon the termination of the authorization (36 CFR 212.1).

Wet Weather Use Regime – Whether or not a road receives significant traffic when it is wet and subject to rutting. ***Restricted*** refers to situations in which traffic is restricted during wet weather by either administrative means (such as a gate), or by natural features (such as being made inaccessible by snow more or less continuously throughout the wet season). ***Unrestricted*** refers to situations in which traffic is not so restricted during the wet season.